Morphological Variations of *Arabidopsis thaliana Caused* by Altered Timing and Exposure Lengths to Red and Far-Red Light

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Introduction

Plants contain various classes of light sensing proteins known as photoreceptors, which can be divided into cryptochromes, phototropins, and phytochromes. Cryptochromes and phototropins respond best to blue light, while phytochromes respond best to red light. Responses include sensing the length of day to regulate hormonal responses, and many aspects of plant morphology and timing of various growth stages. Peak absorbance of phytochrome in its ground state is between 650-670 nm, which absorbs red light very efficiently. Upon activation from the red light, the protein shifts conformation to preferentially absorb far-red or "near infrared" light, at a range of 705-740 nm. The subsequent absorption of far red light will then reversibly conform the protein back to its original form, although the far-red conformation is considered to be the active signaling pathway.

Background

When plants sense far-red light, they are typically shaded from the sun, or believe the sun is setting, as the light bends across the horizon and reaches the plant differently than during the day. Our experiment has artificially disrupted the plants natural growing rhythms and has eliminated the arc of the sun as a moving light source throughout the day. The results will show how these phytochromes have adapted to an atypical environment in that varying conversion from red to far red will have an effect on the germination as well as the growth of the plant through a period of 6 weeks. The germination and subsequent growth of *Arabidopsis thaliana* will be morphologically affected negatively by manipulating its natural light cycles by exposure to varying amounts and timing of light at frequencies in the red and far-r visible spectrum.

Methods

Germination Experiment

Filter paper was placed in 4 separate petri dishes and dampened with distilled water. 20 seeds were pipetted into each petri dish arranged in 5 columns of 4 rows. Red film paper was placed onto two of the dishes; one was attached permanently while the other was removable. The dishes were labeled A-D and placed in the chamber:

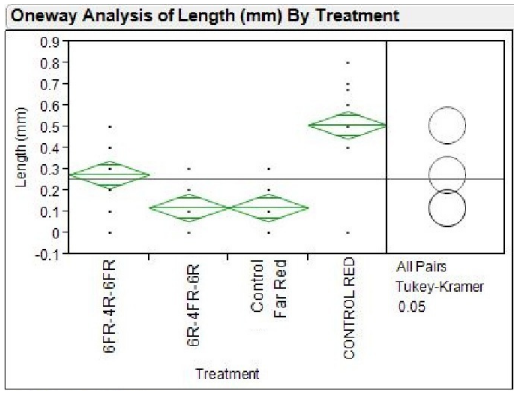
Dish A: Control 16 hours red light (16R)
Dish B: Control 16 hours far red light (16FR)
Dish C: 6R-4FR-6R
Dish D: 6FR-4R-6FR

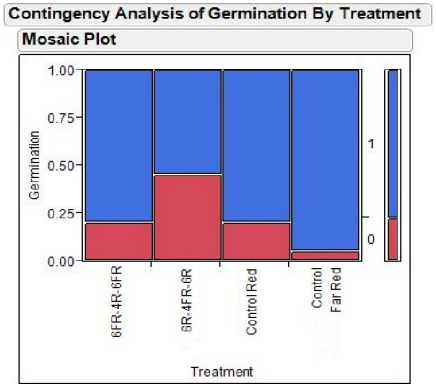
Growth Experiment

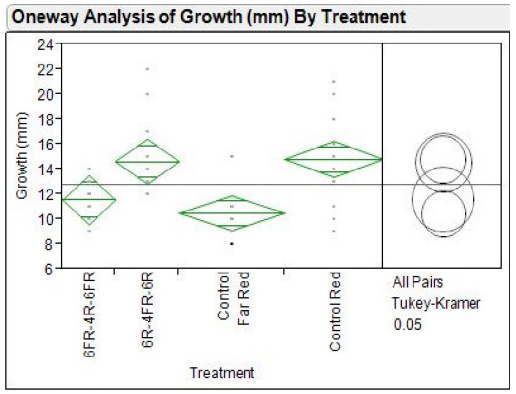
Seeds were stratified in refrigerator. Cell trays were filled with soil and lightly packed. Water was added to soak the soil in preparation for germination. Two Seeds were pipetted into each cell. Humidity dome was placed on both trays a seeds were allowed to germinate for 1 week under identical light treatment. Trays were labeled A-D and placed in the chamber.

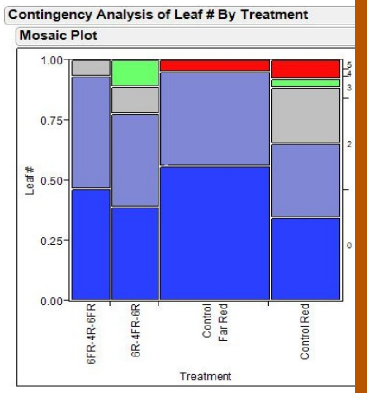
Tray A: Control 16 hour red light (16R)
Tray B: Control 16 hour far red light (16FR)
Tray C: 6R-4FR-6R
Tray D: 6FR-4R-6FR

Data









Results

Significant relationships were noted between the 2 controls in all of the tests conducted as seen by the P values (not shown). Plants exposed to far-red light only either died or were "vertically challenged". Plants exposed to a 4-hr period of far-red light in the middle of the "day" did not experience significant changes in growth. Germination, leaf number and plant height was greatly enhanced by treatment with far-red light only. Leaf number was consistent with height in all treatments, as there was a linear relationship between height and number of leaves counted. The number % of plants killed may have been skewed by a design flaw in which the actual shading mechanism crushed the plants on the outer portion of the tray.

Conclusion

Based on the results from the various treatments it can be concluded that a minimum amount of red light is required for normal physiological responses of *Arabidopsis thaliana*. Minor disruption of red light absorption during the daylight hours (shading) will not significantly impact growth, but extended exposure to far-red light will either stunt growth or kill the plant. Germination and initial growth is enhanced by exposure to far-red light, at least up to 7 days. It is unclear how these plants would have continued to grow however, as the growth experiment was conducted with seeds that were germinated under normal conditions. A separate study is needed to make any correlations between the two done for this experiment.

References

M.Parks, Brian, Peter H. Quail, and Roger P. Hangarter. "Phytochrome A Regulates Red-Light Induction of Phototropic Enhancement in Arabidopsis." Plant Physiology. 110 (1996): 155-162. Print.